International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 7 Issue 3, May-June 2023 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Quantity and Cost Calculations for Several Reinforced Earth Wall Types using Various Reinforcing Materials

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ABSTRACT

Has researched the history and cost analysis of retaining walls. For all wall heights, it was found that geosynthetic reinforced walls were the least costly of all wall types. Koernera examined the numerical example (geosynthetic reinforced walls for various heights) and established that the modified Rankine method is the most conservative, followed by the Federal Highway Administration approach method and the National Concrete Masonry Association approach method. It was. He also demonstrated that the two factors that contributed the most to the segmental retaining walls' (SRWs') poor performance were (i) the use of incorrectly draining fine-grained material for backfilling, and (ii) contractor errors that might have been prevented with effective quality control and inspection.

KEYWORDS: *retaining walls, reinforced walls, Highway, Concrete Masonry, segmental, contractor errors*

How to cite this paper: Roshan Patel | Mr. Hariram Sahu "Quantity and Cost Calculations for Several Reinforced Earth Wall Types using Various Reinforcing Materials" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-7 | Issue-3, June 2023, pp.1129-1139, URL: www.ijtsrd.com/papers/ijtsrd57560.pdf

IJTSRD57560

1. INTRODUCTION

With the advent of (MSE's) mechanically stabilised earth walls (i.e., reinforced layers of soil allowing for modular sequential construction), which were acknowledged as favourable at many locations or in most cases, a paradigm change occurred in the 1960s. Steel straps were used as reinforcement at first, but later welded wire meshes were used as a substitute. RE Wall panels come in a number of materials, including metallic, reinforced concrete, and segmental modules in a range of sizes and forms. The geo-grids, geotextiles, and polymer straps that were used as polymeric synthetic reinforcement in the 1980s to pioneer this mechanically stabilised earth technology were so effective at the site that they are still used today. The mechanically stabilised earth reinforced earth wall is used for a variety of reasons, including ease of construction using blocks, ease of panel placement using manual labour, ease of geosynthetic connection to the facing panels, ease of variation in slope and line due to sequential construction, good tolerance for irregularities, and the ability to obtain any aesthetic view that was not possible with retaining walls. MSE walls are not just limited to low and medium heights; with the addition of soil reinforcement, such as geosynthetic reinforcement, these walls may compete in a range of heights and with walls of other types. For instance, twelve metre high walls and higher are currently existing. Taiwan is home to the biggest, which

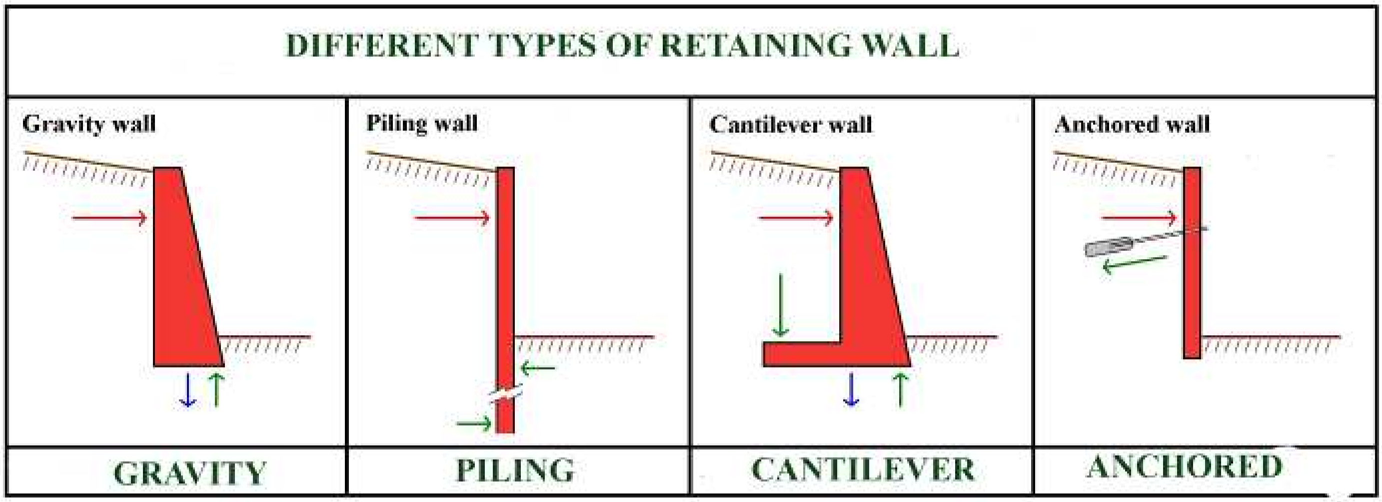

Figure 1 Typical Retaining Walls

The stiffness of the reinforcement is frequently taken into account in analytical solutions for geosynthetic reinforced soil structures. Examples include calculations of the tensile loads and wall outward deformations in reinforced fill over voids, pile-supported reinforced embankments, and shallow footings made of reinforced soil. The assumption that the reinforcing stiffness will never change makes it equal to a material that is linearly elastic. But to varying degrees, these materials are known to be rate-dependent, which means that their stiffness is load-, depends on strain, duration, and temperature (for instance, Greenwood et al. 2012). Using a two-component hyperbolic secant stiffness model with parameters matched to the outcomes of constant-load creep experiments in a database created for this purpose, Bathurst and Naftchali (2021) illustrated this tendency. In the same paper, they showed how the amount of reinforcement secant stiffness can have a quantitative impact on the amount of facing deformations, reinforcement loads created in geosynthetic MSE walls, and reinforcement loads created in the geosynthetic layer used to reinforce a fill over a void. Since every computation was deterministic, only one value of the reinforcement stiffness was used. When a stiffness value is chosen from a) repeated creep experiments on a single material, there is uncertainty in the stiffness value. Product, b) a product group made up of several reinforcing materials belonging to the same product type, and c) a compilation of creep test data obtained from materials for reinforcing that are used in all product categories. The database created by Bathurst and Naftchali (2021) produced some useful results, including information that can be used to measure the statistical variability in estimates of reinforcement stiffness and a linear relationship between isochronous secant stiffness and the ultimate strength of groups of reinforcement products. The current study builds on earlier research by examining the impact of uncertainty in the estimation of reinforcement stiffness used in analytical solutions for the following problems: a) maximum outward-facing deformations of MSE walls; b) maximum reinforcement tensile loads in MSE walls under operational conditions; and c) mobilised reinforcement stiffness in a geosynthetic layer used to reinforce a fill over a void. Every one of the analytical conclusions is accepted as true. The validity of the derived formula

1.1. Objective of Retaining Walls

The primary objective of retaining walls is to provide stability and support to soil or other materials, preventing erosion and controlling the movement of land or structures. Retaining walls serve various purposes and can be found in a wide range of applications, including:

1. **Soil Retention**: One of the main objectives of retaining walls is to hold back soil and prevent it from sliding or eroding. Retaining walls are commonly used in areas with slopes or uneven terrain to create level surfaces for buildings, roads, or landscaping.
2. **Slope Stabilization:** Retaining walls help stabilize slopes and prevent landslides or soil movements. By providing structural support and holding back the soil, they can mitigate the effects of gravity and maintain the integrity of the slope.
3. **Erosion Control:** Retaining walls can effectively control erosion by preventing soil erosion caused by water flow. They act as barriers, redirecting and managing the flow of water to protect the surrounding area from damage.
4. **Creating Usable Spaces:** Retaining walls can be used to create terraced or stepped areas on sloping land, allowing for the creation of usable spaces for gardens, recreational areas, or building foundations.

5. **Aesthetics and Landscaping:** Retaining walls can enhance the aesthetics of a landscape by providing visual interest and defining different levels or areas within a property. They can be constructed using various materials and designs to complement the overall design and style of the surroundings.
6. **Structural Support:** In some cases, retaining walls are designed to provide support to structures by preventing soil movement that could compromise their stability. These walls are commonly used in foundation walls or basement construction to resist lateral soil pressure.
7. Calculation of quantities and cost for various types of reinforced earth wall with different type of reinforcing material.
8. Calculating the cost of Retaining wall at different heights
9. Calculating the Quantity of various components of the retaining wall and reinforced earth wall
10. Design of Reinforced Earth wall and R.C.C Retaining Wall for different heights.

The specific objectives of a retaining wall project depend on factors such as the site conditions, soil properties, desired use of the land, and project requirements. Proper design, engineering, and construction practices are essential to ensure that the retaining wall meets its intended objectives and performs effectively over its intended lifespan.

1.2. Future Scope of Retaining Walls

The future scope of retaining walls is influenced by ongoing advancements in materials, construction techniques, and design practices. Here are some potential future developments and trends in the field of retaining walls:

1. **Sustainable Materials:** There is a growing focus on sustainable construction practices, and this applies to retaining walls as well. Future retaining walls may incorporate eco-friendly materials such as recycled aggregates, geosynthetics, or bio-based materials to reduce environmental impact and promote sustainability.
2. **Smart and Innovative Design:** Advancements in technology may enable the development of smart retaining wall systems. These systems could incorporate sensors and monitoring devices to provide real-time data on factors such as soil movement, stress distribution, and overall structural health. This information can help with early detection of potential issues and facilitate timely maintenance or repairs.
3. **Reinforcement Techniques:** Retaining walls may see advancements in reinforcement techniques to enhance their strength and durability. Innovations in reinforcement materials, such as high-strength geosynthetics or carbon fiber composites, could provide increased load-bearing capacity and improved performance.
4. **Integrated Drainage Systems:** Future retaining walls may integrate drainage systems that effectively manage water flow and reduce hydrostatic pressure behind the wall. This can help prevent water-related issues, such as seepage, erosion, or frost heave, which can affect the stability of the wall.
5. **Modular and Prefabricated Systems:** The use of modular or prefabricated retaining wall systems may increase in the future. These systems offer advantages such as faster construction, cost savings, and ease of installation. They can be designed to accommodate various site conditions and provide flexibility in terms of height, alignment, and aesthetics.
6. **Sustainable Landscape Integration:** Retaining walls can contribute to the overall aesthetics and ecological balance of a landscape. Future retaining wall designs may focus on integrating greenery, vegetation, or vertical gardens into the structure, enhancing visual appeal and ecological benefits.
7. **Climate Change Adaptation:** With climate change impacts becoming more prevalent, retaining walls may need to be designed and engineered to withstand changing weather patterns, increased rainfall, or more frequent extreme events. Future retaining walls may incorporate climate-resilient design features to ensure long-term performance in a changing environment.

These are just some potential future directions for retaining walls. As technology advances and sustainability becomes a greater focus, the field of retaining walls is likely to see continued innovation and development in the years to come.

2. LITERATURE REVIEW

Schmidt and Harpstead (2010) Disconnection between the members of the design team can be blamed for the poor performance of mechanically stabilised earth (MSE) walls that were developed and built using the conventional method. The design team members frequently do not have access to the geotechnical studies, which frequently do not provide site-specific design requirements. Designs are created using usual values that are expected or publicised,

which leads to subpar performance or, alternatively, the requirement for expensive change orders. We suggest a modification in the design process after investigating the actions and circumstances that led to multiple MSE walls that performed badly. Prior to the project being put out to bid, the design should be created concurrently with the civil and structural parts of it. To ensure that construction meets the required requirements and that every aspect is properly recorded, quality assurance and quality control should be an essential part of the process. Such documentation enables owners to identify, and if required seek, solutions for, MSE wall underperformance. A case study that supports our research findings demonstrates many of the disconnects between members of the design team as well as deficiencies in QA and QC that cause MSE walls to perform poorly.

Evangelista (2011) With regard to an ideal vertical plane going through the heel of the wall, several approaches are used to assess active earth pressure on cantilever retaining walls. According to research by Anna Scott, the wall has a long heel and failure planes that don't obstruct the vertical stem, allowing the limit Rankine conditions to develop unhindered in the backfill. Based on the geometry of the ground level and the friction angle, lateral motions along the ideal plane are considered to have an inclination that is constant. In his innovative technique, he suggested using a pseudo-static stress plasticity solution to calculate the active earth pressure coefficient as a result of seismic loading.

Koerner and Koerner (2011) over the past thirty years, the use of geogrids and geotextiles to strengthen mechanically stabilised earth (MSE) walls has increased significantly. However, this expansion has also been accompanied by a number of failures, including severe deformation and, in some cases, outright collapse. Inappropriate drainage control was the culprit in 68 instances out of the 82 cases in the author's database. As a result, the internal drainage problems within the reinforced soil mass (46) and the exterior drainage problems surrounding the soil mass (22) are the main topics of this work. Some classic design components will be shown after a quick introduction to the technology. The crux of the study will then be the debate between proper and incorrect drainage management techniques. A synopsis

Vashi et al. (2011) Geosynthetic qualities in reinforced earth retaining walls (REW) are strongly influenced by the fill material performance and its interface friction properties with geosynthetics. The effectiveness of cohesive soil and flyash combination as reinforced earth wall fill material is covered in this study. Triaxial testing in the lab has been used to conduct research to evaluate the cohesive soil's strength when combined with flyash. According to the findings, a fly ash and cohesive soil mixture has better interface friction, greater strength, and stiffness. The mixes' technical performance complies with the specifications for geosynthetically reinforced earth retaining walls. As a result, this composite infill material can be employed in areas where graded sand is either in short supply or unavailable.

Koseki (2012) Junichi Koeski presented the benefits of employing geosynthetics in enhancing the seismic performance of earth constructions after studying case studies from Japan and pertinent model test results. By concentrating on a number of important elements, including face stiffness, the arrangement and characteristics of reinforcements, and backfill and subsoil conditions, geosynthetic-reinforced soil retaining walls have been researched. Additionally, other uses of the geosynthetic reinforcement technology are discussed, including its conjunction with other reinforcing techniques, use on bridge abutments and piers, and use on ballasted railway lines.

Peia and Xia (2012) Using automated design and cost-cutting techniques, reinforced cantilever retaining walls (RCRW) are the focus of this article. Geometrical restrictions and design specifications are applied as design constraints in the analysis. 25 restrictions are created, and 9 parameters are chosen to define the structure. The restricted optimisation model is solved using three heuristic algorithms: the genetic algorithm (GA), particle swarm optimisation (PSO), and simulated annealing (SA). By using a sample design, the calculation programmes have been created and verified. Results demonstrate that cost reduction design of RCRW may be successfully implemented using heuristic optimisation techniques. It is discovered that no algorithm performs better than others. It is advised to employ PSO in terms of efficacy and efficiency.

Bobet (2012) For sustaining earth fills in civil infrastructure projects throughout the past three decades, mechanically stabilised earth (MSE) retaining walls have become more popular as design alternatives to conventional reinforced concrete retaining walls. MSE walls are more affordable than reinforced concrete walls and are capable of supporting surface applied loads and holding back substantial heights of earth fills. MSE walls are particularly ideal for challenging foundation soil conditions when differential settlements are predicted since they are flexible and mechanically redundant constructions. MSE retaining walls typically consist

of structural fill that has been strengthened with inclusions that are tensile-resistant and attached to facing elements. The mechanical interactions of the reinforced soil structure's three components—fill material, reinforcement, and soil—provide internal stability.

Kayabekir et al. (2020) The acquisition of minimising both the cost and the CO2 emission of the reinforced concrete retaining walls in conjunction with ensuring stability conditions has been investigated using harmony search algorithm in this study, taking into account the eco-friendly design requirements of reinforced concrete structures. The contribution rate of each variation to the cost and CO2 emission was determined through the application of optimisation studies with two different goal functions. In addition, multi-objective analysis was used to determine the integrated relationship between cost and CO2 emission in order to find a design that is both economical and environmentally good. The breadth of the foundation and the height of the stem were considered design considerations. In regard to the modification of the excavation depth, the fictionalisation of certain optimisation situations system at the backfill side, the backfill soil's unit weight, the prices, and the concrete and reinforcing bars' combined CO2 emissions. In light of the comparison of the findings of the defined goal functions, the results of the optimisation analyses were structured to explore the potential of providing an eco-friendly design of retaining walls with the reduction of both cost and gas emission. According to manual calculations and the flower pollination algorithm, the suggested strategy is successful in obtaining both economic and ecological results.

Majumder et al. (2023) this study examines how well geosynthetic reinforced soil (GRS) walls, sometimes referred to as earth walls and backfilled with marginal soil, perform. Granular soil has been utilised as backfill material most frequently throughout the years because of its high strength, outstanding drainage properties, and simplicity of compacting. Granular dirt is, however, scarce at many highway project sites due to transportation problems and lack of supply. The term "marginal soil" refers to soil with particles larger than 15% or with a plasticity index greater than 6. The use of marginal soil as the GRS wall backfill is subject to significant design restrictions because to its poor drainage, low shear strength, and formation of pore water pressure because of the presence of fines. In this study, marginal backfill performance is compared. To do this, a two-dimensional finite element model has been created to investigate the performance of the GRS wall in a dry state. The effects of surcharge, reinforcement length, spacing, wall facings, and wall height have all been studied further parametrically. The primary performance criterion has been identified as the wall displacement. The investigations have shown that marginal soil may be utilised as backfill as long as a stronger geogrid is employed, according to the findings. In order to comprehend the deformation behaviour of the wall utilising marginal fills, a real-world case study for various heights of GRS wall sections has been investigated.

J et al. (2023) Using analytical solutions for a) the maximum outward facing deformation in mechanically stabilised earth (MSE) walls, b) the maximum reinforcement tensile loads and strain in MSE walls under operational conditions, and c) the mobilised reinforcement stiffness in a geosynthetic layer used to reinforce a fill over a void, the paper investigates the quantitative influence of uncertainty in the estimate of geosynthetic reinforcement stiffness on numerical outcomes. An isochronous two-parameter hyperbolic load-strain model is used to simulate the reinforcement's stiffness. When product-specific creep data are not available at the time of design, reinforcement stiffness is estimated using a linear connection between isochronous stiffness and the ultimate tensile strength of the reinforcement. Results of the solutions are reported in both deterministic and probabilistic ways. The statistical relationship between nominal safety factors in contemporary performance-based design, the latter is preferred to measure margins of safety within a probabilistic framework. The research concludes by emphasising the practical advantage of utilising data on isochronous secant stiffness particular to a product when it is available as opposed to predictions of isochronous stiffness values based on reinforcing type or pooled data.

3. Design Methodology of Retaining Wall

The design methodology for a retaining wall involves several steps to ensure a safe and structurally sound wall that can withstand the applied forces and conditions. Here is a general outline of the design process:

1. **Site Investigation:** Conduct a thorough site investigation to understand the soil conditions, groundwater levels, slope stability, and any other relevant site-specific factors. This may involve geotechnical testing, such as soil borings, laboratory testing, and analysis of site data.
2. **Design Objectives:** Define the design objectives, including the purpose of the retaining wall, desired height, aesthetics, and any specific requirements or constraints. Consider factors such as the level of retained material, loads on the wall, and potential surcharge loads.

3. **Design Approaches:** Determine the appropriate design approach based on the site conditions and project requirements. Common approaches include gravity walls, cantilever walls, anchored walls, or mechanically stabilized earth (MSE) walls. Each approach has its own design principles and considerations.
4. **Structural Design:** Perform structural design calculations to determine the dimensions and reinforcement requirements of the retaining wall. This includes evaluating stability, analyzing forces and moments, and selecting appropriate materials. Consider factors such as lateral earth pressure, global stability, bearing capacity, and seismic loads.
5. **Drainage Design:** Incorporate drainage features into the retaining wall design to manage water pressure and prevent excessive hydrostatic forces. This may include weep holes, drainage pipes, geotextiles, or other drainage systems to ensure proper water management behind the wall.
6. **Construction Specifications:** Prepare construction specifications and drawings that provide detailed information on materials, construction methods, reinforcement details, backfill requirements, and any special considerations. This helps ensure that the wall is constructed according to the design intent.
7. **Safety and Codes:** Ensure compliance with local building codes, regulations, and safety standards. Consider factors such as seismic design, lateral pressures, soil bearing capacity, and any other relevant code requirements.
8. **Monitoring and Maintenance:** Establish a plan for monitoring the performance of the retaining wall after construction. This may involve regular inspections, instrumentation, or maintenance activities to address any potential issues and ensure long-term stability.

It is important to note that retaining wall design can be complex and may require the expertise of a professional engineer specializing in geotechnical engineering or structural engineering. The design methodology may vary depending on the specific site conditions, project requirements, and applicable design codes and standards.

3.1. Design Procedure of Retaining Wall

The design procedure for a retaining wall involves a systematic approach to ensure the stability, strength, and functionality of the wall. While the specific steps may vary depending on the project requirements and design standards, here is a general outline of the design procedure for a retaining wall:

1. **Determine Design Parameters:**
- Identify the purpose and function of the retaining wall.
- Define the height and length of the wall.
- Determine the type of retained material (soil, rock, etc.).
- Determine the level of surcharge loads and any other applied loads.

2. **Site Investigation:**
- Conduct a geotechnical investigation to obtain information on soil properties, groundwater levels, and slope stability.
- Perform geotechnical testing, including soil borings, laboratory tests, and analysis of soil samples.

3. **Determine Earth Pressure Distribution:**
- Determine the type of earth pressure distribution acting on the wall (active, passive, or at-rest).
- Calculate the magnitude of earth pressure based on Rankine's theory, Coulomb's theory, or other applicable methods.
- Consider the effects of water pressure, if applicable.

4. **Structural Design:**
- Select the appropriate retaining wall type based on the project requirements and site conditions (gravity wall, cantilever wall, anchored wall, MSE wall, etc.).
- Determine the dimensions of the wall, including height, base width, and toe and heel dimensions.
- Perform structural calculations to determine the reinforcement requirements, including steel reinforcement or geosynthetic reinforcement, if applicable.

5. **Stability Analysis:**
- Perform stability analysis to ensure the overall stability of the retaining wall system.
- Analyze the global stability, including overturning, sliding, and bearing capacity checks.
- Consider the effects of seismic loads, if applicable.

6. **Drainage Design:**
- Incorporate appropriate drainage measures to manage water pressures behind the wall.
- Design and specify drainage features, such as weep holes, drainage pipes, geotextiles, or other drainage systems.

7. Prepare Construction Drawings and Specifications:

- ➢ Prepare detailed construction drawings and specifications that include dimensions, reinforcement details, backfill requirements, and any special instructions.
- ➢ Consider construction methods and sequence to facilitate the construction of the retaining wall.

8. Construction Monitoring and Inspection:

- ➢ Implement a monitoring and inspection plan during the construction phase to ensure adherence to design specifications.
- ➢ Monitor construction activities, backfill placement, and compaction.
- ➢ Conduct inspections to verify compliance with design requirements.

It's crucial to note that the design procedure for a retaining wall should be carried out by a qualified engineer with experience in geotechnical and structural engineering. The design process may involve detailed calculations, analysis, and adherence to local building codes and regulations.

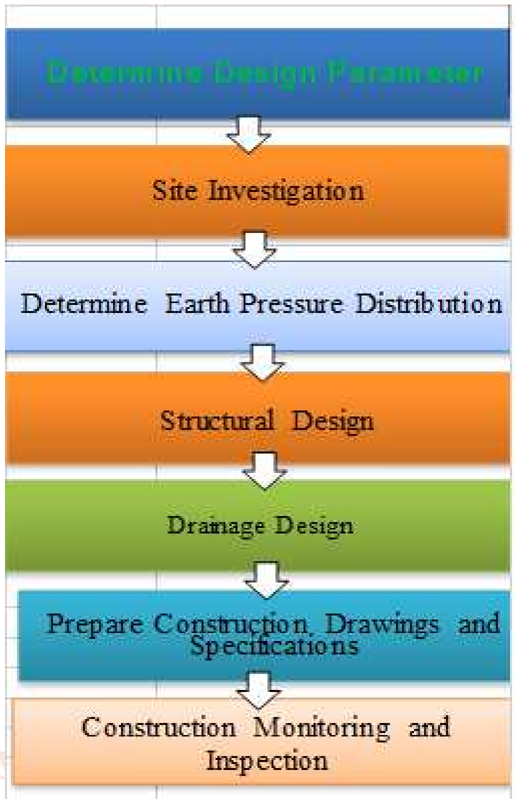

Figure: 1 Flowchart of Retaining Wall

3.2. R.C.C. Counterfort Retaining Wall For Height Of 7.0 M

Grade of concrete	=	30Mpa		
S.B.C. of soil	=	140	Kn/Sqm	
Density of soil	=	20	KN/cum	
Height of embankment above GL	=	7	m	
Grade of steel	=	500	Mpa	
Density of Concrete	=	25	Kn/m	
Friction Coefficient	=	0.5		
Active earth Pressure	=	0.33		
Angle of wall friction	=	20	Deg	0.3491 radians
Angle of internal friction	=	30	Deg	0.5236 radians
Coefficient of active earth Pressure (Ka)	=	1+sin Ø=		0.33
Ka	=	1-Sin Ø		

Dimensions of Retaining Wall

Minimum Depth of foundation (y)

Y (min)	=	qox Ka2 / γ	=	0.8 m
Provide minimum Depth of Foundation	=	1.0 m		
Height of wall above ground level	=	7.0 m		
Overall depth of Foundation (H)	=	(7+1) =		8.0 m
Base Width (b)	=	0.7 H =		6.2 m
Thickness of base slab	=	2lh		
Where,	=	clear spacing of counter fort		
	=	3.5 m		
	=	H (1/4) Y		
	=	2.78 m		
Consider it as	=	3.0 m c/c		
Thickness of base slab	=	2lh	= 4.8 m	
			= 0.5 m	
	=	500 mm		

Toe Projection = 1 * Base Width = 1.55 m
4

Clear height of Stem = H- thickness of base
= 7.5 m

Thickness of stem = 0.2 m

Heel Projection = B – toe projection – Thickness of stem
= 4.45 m

Horizontal pressure = Ph = 1 * Ka* γ * h2
2
= 213.33 KNm

Bending moment = Mu = Ph * l2
12
= 160 KNm

Factored moment = 1.5 * mu
= 240 KNm

Effective depth = d = √ Mu (Ru = 0.138 fck)
(Ru*b)

= 240.77 mm

Provide 16 mm dia bar and 40 mm clear cover

Overall Depth = D = d + dia of bar + clear cover
2

D = 288.77 mm

Provide over all depth as 300 mm

d= D - dia of bar + clear cover
2

= 252 mm

Area of steel r/f = 0.5 * fck (1- (√1-(4.6*Mu))*b*d
fy fck*b*d2
= 0.03 * 0.22 * 45000
= 1637.70 mm2

Spacing using 16 mm dia bars = (π * D2 * b)
4 * Ast

= 253.47 mm

Assume spacing as 250 mm c/c.

3.3. Design for reinforced RE Wall with metallic strips for Height of 7.0 m

Height of embankment above GL = 7.0m

The values for Grade of concrete, S.B.C. of soil, Density of soil, Grade of steel, Density of Concrete, Friction Coefficient, Active earth Pressure, Angle of wall friction, Angle of internal, Coefficient of active earth Pressure (Ka) is kept same as that for Reinforced RE wall for the height of 4.0m.

Dimensions of Wall

Provide minimum Depth of Foundation	=	1.0 m
Height of wall above ground level	=	7.0 m
Overall depth of Foundation (H)	=	8.0 m
Base Width	=	4.9 m
Lateral earth Pressure	=	33.33 KNm
Horizontal Pressure	=	147.00 KN/m

Assume horizontal and vertical spacing of strips 1.0m		
Width of strips	=	0.1 m
Density of material to be used in filling	=	18 Kn/m2
Yield strength in steel	=	2, 50, 000 Kn/m2

Height of strips to be considered for RE wall		
Considering clear cover from foundation	=	0.5 m
Considering clear cover from top	=	0.5 m
Height in which reinforcement is to be provided	=	7.0 m
No of reinforcements	=	7.0 m
Force at reinforcement	=	72 Kn

Provide thickness as 15.0 m

Stability against sliding

Safe

Stability against Overturning

Safe

Bearing Pressure

Safe

4. QUANTITIES FOR RETAINING WALL AT 7m HEIGHTS

Table 1 RETAINING WALL for 7m Height

Sl. No.	Description of works	Unit	Length	Width	Height	Qty	Total Quantity
A	Earth work in Excavation						
		cum	10.000	6.500	1.000	65.000	
				TOTAL Earth work		65.000	65.000
B	PCC M-15 Grade Concrete						
	M-15 G. Con.	cum	10.000	6.200	0.150	9.300	
				TOTAL M-15		9.300	9.300
C	RCC M-30 Grade Concrete						
i	M-30 .G. con Raft	cum	10.000	6.200	0.500	31.000	
ii	M-30 WALL	cum	10.000	0.500	7.500	37.500	
iii	M-30 Counterfort	cum	3.300	0.200	4.73	3.122	
				TOTAL M-30		71.622	71.621
D	TOTAL Quantity of Steel	MT					6.30

Table 2 Retaining Wall for 7 m Heigh

Item No as per SOR 2014	Description	Unit	Rate	Quantity	Amount
3.2	Earthwork in Excavation in ordinary rock by Manual Means Excavation in ordinary rock including loading in a truck and carrying of excavated material to embankment site with all lifts and leads	Cum	226.00	65.00	14,690
9.1	PCC M-15 in Foundation Plain cement concrete M-15 mix with crushed stone aggregate 40 mm nominal size mechanically mixed, placed in foundation and compacted by vibration including curing for 14 days.	Cum	4,209.00	9.30	39,144
13.6	Plain/Reinforced cement concrete in sub-structure complete as per drawing and technical specifications.	Cum	6,588.00	71.62	471,844
13.7	TMT / HYSD Reinforcement: in Retaining walls as per Technical Specification Clause 1600.	MT	75,415.00	6.30	475,320
	Total Amount				1,000,998

Table 3 Re Facia Wall for 7m Height

Sl. No.	Description of works	Unit	Length	Width	Height/ Depth	Qty	Total Quantity
A	Earth work in Excavation						
		cum	10.000	5.500	1.000	55.000	
				TOTAL Earth work		55.000	55.000
B	GSB Below Leveling PAD						
	GSB Below Leveling PAD	cum	10.000	5.500	0.150	8.250	
				TOTAL GSB		8.250	8.250
C	PCC M-15 Grade Concrete						
	M-15 G. Con. Leveling Pad	cum	10.000	0.450	0.150	0.675	
				TOTAL M-15		0.675	0.675
C	RE wall Fill And Geo Grid						
i	RE wall Fill	cum	10.000	4.900	8.000	392.000	
ii	RE wall facia panel	Sqm	10.000	1.000	8.000	80.000	
iii	Geo Grid	cum	10.000	4.900	8.000	392.000	
						864	864

5. Conclusions

1. The Retaining wall has been built for a height of 7 metres in order to compare the cost effectiveness of the Retaining wall and reinforced earth walls. As the retaining wall tends to disintegrate after a particular height, this is a well-known fact. Counter forts are built to retaining walls to stabilise them, and the same has been planned for retaining walls that are 7 metres, high. Similar to that, 7m, high reinforced earth walls, often known as RE walls, have been designed for use.
2. Due to the fundamental differences in design, enormous amounts of concrete and steel bars are typically needed in retaining walls as opposed to RE walls, which accounts for the majority of the cost difference.
3. The retaining wall is built with the assumption that the earth will be kept behind it and that earth back fill will place most of the weight on the wall. In contrast, the friction between the soil and the reinforcement in the reinforced earth wall distributes the load, which is subsequently transmitted to the ground. As a result, the reinforcement becomes tense and the ground seems to have cohesiveness.
4. With an increase in wall height, a greater economic gain is realised from the reinforced earth wall.
5. The internally stabilised walls, also known as RE walls, can save anywhere between 40% and 65% of their original cost. Additionally, depending on the soil and loading circumstances, several types of Geo grid and back fill material can be used to create a RE wall that is more cost-effective..

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